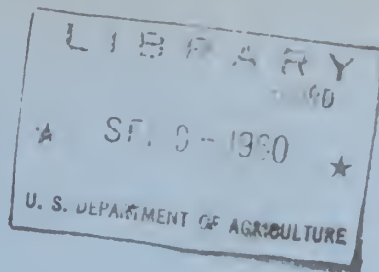


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**RESEARCH FOR
BETTER QUALITY
IN DRIED FRUITS**



Prunes

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

THIS REPORT is one of four on dried fruit research conducted during 1958 and 1959 at the Western Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, Albany 10, Calif. The Dried Fruit Industry Research Advisory Committee has worked closely with this division in support and evaluation of this research program. The assistance of the following groups is gratefully acknowledged:

California Dried Fig Advisory Board
California Raisin Advisory Board
California Prune Advisory Board
Dried Fruit Association of California

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Contents

	page
Materials and methods	4
Alcohol extractable color	4
Moisture determination	4
Sugars	6
Visual and tactile changes	6
Weight changes in retail packages	6
Flavor	6
Results and discussion	6
Color changes	6
Moisture and weight changes	8
Flavor changes	8
Sugar content changes	8
Visual appearance	8
Summary	13
Literature cited	14

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RESEARCH FOR BETTER QUALITY IN DRIED FRUITS

PRUNES

F. S. Nury, D. H. Taylor, and J. E. Brekke

An estimate from average production for the past 5 years (12)¹ indicates that the California dried prune industry produces about 70 per cent of the world supply of dried prunes. The prunes are considered to have good quality; however, like other dried fruits, dried prunes undergo deteriorative changes when exposed to unfavorable conditions, which tend to reduce their consumer acceptability.

This study was conducted to determine the chemical and quality changes that may take place in retail packages of processed dried prunes, such as "sugaring", loss in flavor, discoloration of flesh, and growth of molds and yeasts under a wide range of atmospheric temperatures and relative humidities. The objectives were chiefly to provide specific information for growers, processors, and distributors regarding the stability of dried prunes, to indicate improved methods to enhance stability, and to devise improved methods for measuring quality.

The term "processed" refers to dried prunes that have gone through the several operations involved in retail packing. The important steps include grading, sorting, washing, immersion in hot water, and packaging.

A study of the literature reveals little information on large-scale experimentation concerned with deteriorative changes in retail packages of processed dried prunes. Information concerning various phases of research, including work on bulk storage, has been reported by a number of investigators. Chari et al. (4) have reported on the effects of blanching and dehydration on enzyme activity and storage quality of high-moisture unprocessed prunes. Yeasts causing souring and those associated with sugaring of dried prunes, dates, and figs have been investigated by Esau and Cruess (6) and by Baker and Mrak (2). General quality of dried prunes and the effect of harvesting time on yield and quality have been reported by Claypool and Kilbuck (5) and Kilbuck et al. (8). A number of other studies on deteriorative changes associated with bulk storage of dried fruits in general and with prunes have also been reported (3, 10, 11).

¹Numbers in parentheses refer to Literature Cited, p. 14.

Materials and Methods

The dried prunes used were of medium size, processed and packed by a commercial packing plant in the Santa Clara Valley of California during the crop year 1957. They were prunes from lots that were distributed to the retail trade. Two lots, each consisting of 216 one-pound retail packages of prunes of known composition (table 1) were used. One lot was packed in transparent saran-treated cellophane bags (K202) and another in cartons with foil-laminated paper overwrap. The packages were placed in specially designed chambers (fig. 1). The chambers maintained temperatures in the range of 35° to 90° F. within ± 1 degree and relative humidities from 40 to 80 percent within ± 2 percent. The experiments were carried on for 5 to 16 months, depending on the temperature of storage; the samples stored in various chambers were removed periodically and subjected to objective tests.

Alcohol Extractable Color

A 15-gram sample of well mixed ground dried fruit was placed in a 300-ml. Erlenmeyer flask containing 200 ml. of 50 percent ethanol. The flask was then covered with Parafilm² and allowed to remain at room temperature for 23 hours with occasional shaking. The colored solution was then filtered through Whatman No. 2 filter paper and the color reading made with the aid of a Bausch and Lomb spectrophotometer (Spectronic 20) at 440 m μ using a 1.2 cm. cell. The results are recorded in absorbance units ($A = \log_{10} \frac{1}{I}$) with a 50 percent ethanol solution used for zero adjustment. These results are converted to a moisture-free basis by dividing the observed absorbance value by the fraction of the original sample that was total solids.

Moisture Determination

Moisture determinations were made by the vacuum-oven method. The procedure employed, with some modification, was that of the Association of Official Agricultural Chemists (1) and Makower, Chastain, and Nielsen (9). A number of analyses were also made by the dried fruit moisture tester (DFA meter)³ in order to compare the two methods. In the vacuum-oven determinations a 4-gram sample of well blended, ground dried fruit weighed accurately to 1 mg. was placed in a moisture dish containing 5 grams of washed and ignited coarse sand and a short stirring rod. The contents of the moisture dish were stirred and well mixed. (The rod is not removed during the course of moisture determination.) The

²Mention of specific products does not imply recommendation by the Department of Agriculture over others of a similar nature not mentioned.

³Dried Fruit Association of California.

Table 1. --Initial analyses of whole¹ prunes in stability study

Determinations	Bags (K202)	Cartons
Moisture (by vacuum oven method), pct- - -	26.82	26.16
Moisture (Dried Fruit Assoc. moisture meter), pct - - - - -	24.4	24.1
Sugar content, pct. Total - - - - -	41.2	40.8
Reducing - - - - -	39.8	39.2
Fructose - - - - -	18.1	17.7
Glucose - - - - -	21.7	21.5
Sucrose - - - - -	1.40	1.6
Crude fiber, pct - - - - -	8.9	6.3
Nitrogen, pct - - - - -	.42	.42
Ash pct - - - - -	1.48	1.49
Acidity (ml. of 0.1N NaOH to bring 100-gram sample to pH 8) - - - - -	-170.2	161.3

¹Pits included.



Figure 1. Constant-temperature, constant-relative-humidity chambers used in dried-fruit stability tests.

dish was placed on a steam bath for 15 min. and then transferred to the vacuum oven for 30 hrs. at 60° C. at less than 2 mm. Hg. pressure. Moisture is expressed as percentage of original sample weight.

Sugars

The method of Munson-Walker (1) was employed for total and reducing sugars and that of Williams and Potter (13) for fructose determinations. Sucrose and glucose are determined by difference.

Visual and Tactile Changes

The samples which were withdrawn for various analyses were examined for changes in texture, sugaring, and growth of micro-organisms.

Weight Changes in Retail Packages

Four commercially packed retail packages of each dried fruit packed in K202 and four in cartons with foil-laminated paper overwrap were weighed periodically throughout the experiments to the nearest 0.5 gram on a Toledo balance.² The weight changes in these unopened packages are expressed as percentage of the original weight.

Flavor

Representative samples of dried fruits were withdrawn from the storage chambers at various intervals, hermetically sealed in No. 2 cans, and stored at -30° F. for subsequent determination of flavor changes by a laboratory taste panel as well as by a panel of members of the dried fruit industry. A control group was kept at -30° F. for the comparisons made by triangle taste tests (7).

Results and Discussion

Color Changes

The results of color analyses, with a 50 percent ethanol solution used as extracting solvent, can be seen in figures 2 and 3 for prunes held at 60 percent relative humidity and various temperatures. Relative humidity in the range of 40 to 80 percent had little or no effect on color changes. The data provided are thus for 60 percent relative humidity at temperatures of 35°, 50°, 70° and 90° F. The rates of darkening varied at 50°, 70° and 90° F., but no significant difference in rate of darkening was noted between 50° and 35° F. However, even at 35° and 50° F the darkening was measurable. An extracted color absorbance

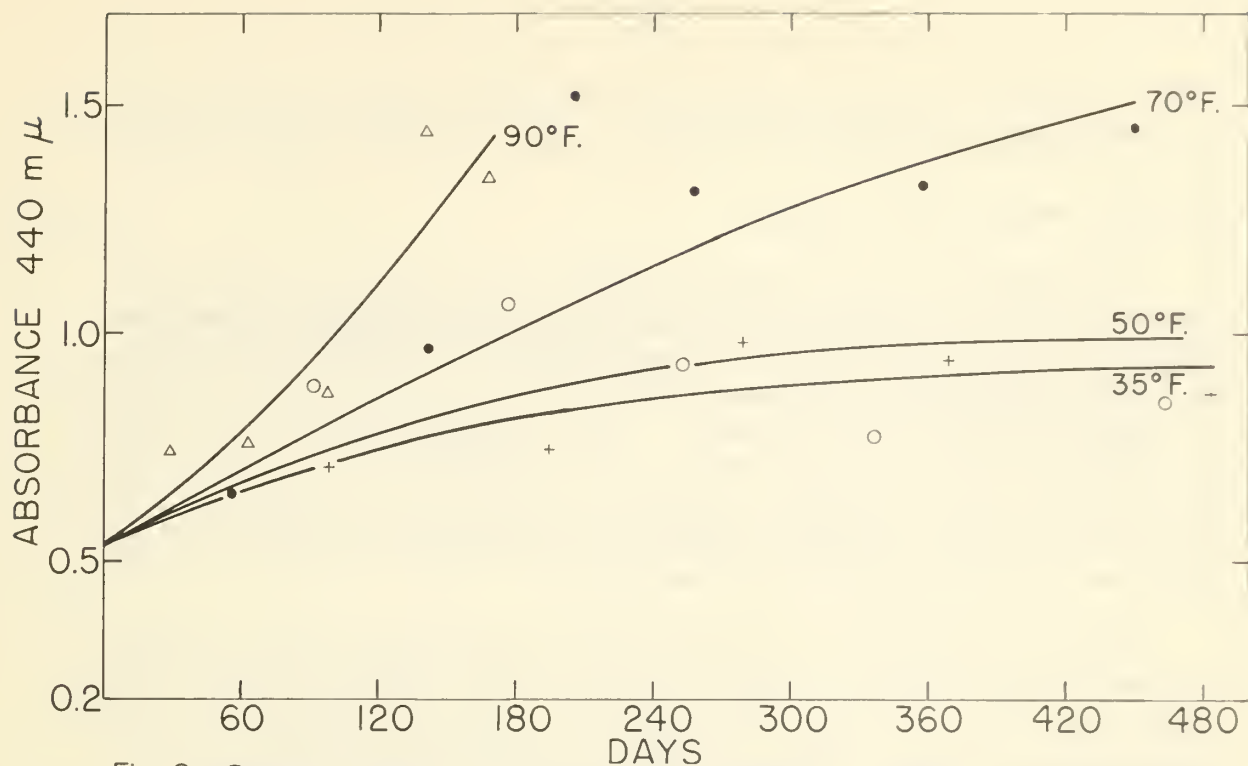


Fig. 2: Prunes, Bags, 60% RH. 50% Alcohol Extractable Color (M.F.B.)

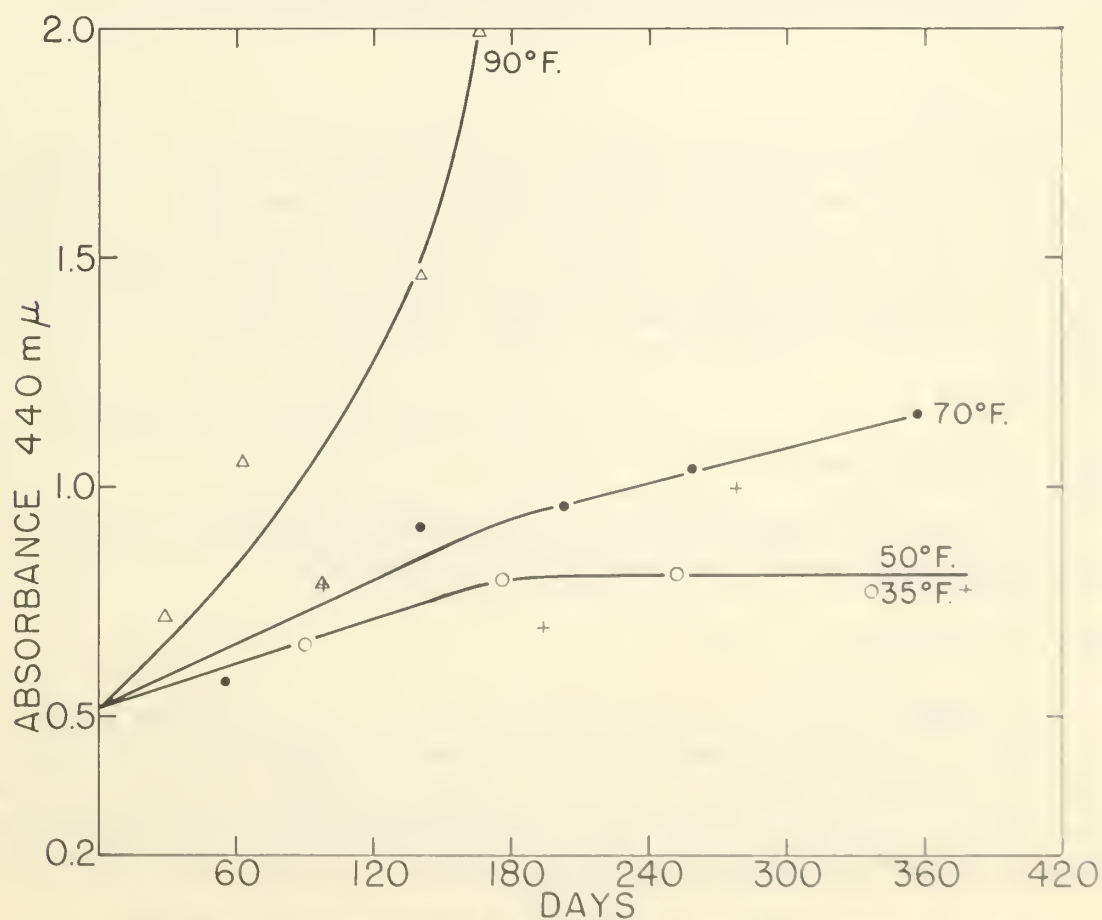


Fig. 3: Prunes, Cartons, 60% RH. 50% Alcohol Extractable Color (M.F.B.)

value of about 1.3 usually indicates the fruit has suffered loss in flavor and increased flesh discoloration, and is of general poor quality.

Moisture and Weight Changes

The fluctuations in moisture content and weight of the retail packages of prunes were dependent on initial moisture content of the fruit, type of packaging material, and temperature and humidity to which the package was exposed. Figures 4 to 9 show the changes in gross weight of retail packages of dried prunes. These data and vacuum-oven moisture analyses show that the prunes were in equilibrium with air at about 80 percent relative humidity. Losses in weight were noted at 40 and 60 percent relative humidity, the losses being higher at higher temperatures but significant also at 35° and 50° F.

Moisture losses up to 8 percent were recorded at 70° F. and 40 percent relative humidity after 14 months. The results of final vacuum-oven moisture analyses of prunes stored at various atmospheric conditions appear in table 2. The variability in analytical results due to heterogeneity of the samples was pronounced. Comparison of the vacuum-oven with the conductometric method of moisture analysis showed that the conductometric method generally gave lower moisture values.

Flavor Changes

Bagged prunes stored at 90° F. for 12 weeks, 70° F. for 56 weeks, and 50° F. for 60 weeks, all at 60 percent relative humidity, were judged different from the control by triangle taste tests. Several expert tasters from the prune industry gave controls and carton-packed prunes held at 50° F. for 5 months equally high scores. Samples stored at 90° F. for 3 months received a slightly lower score than those stored at 70° F. for 15 months.

Sugar Content Changes

No changes in sugar content on the moisture-free basis were observed under any of the conditions of the experiment.

Visual Appearance

The surface of the prunes became very moist and syrupy at 90° F. and 80 percent relative humidity and to a lesser degree at 90° F. and 60 percent relative humidity, both in cartons and bags; the latter showed a more pronounced effect. Two of the bags at 90° F. and 80 percent RH showed evidence of mold growth after 3 months, perhaps due to package

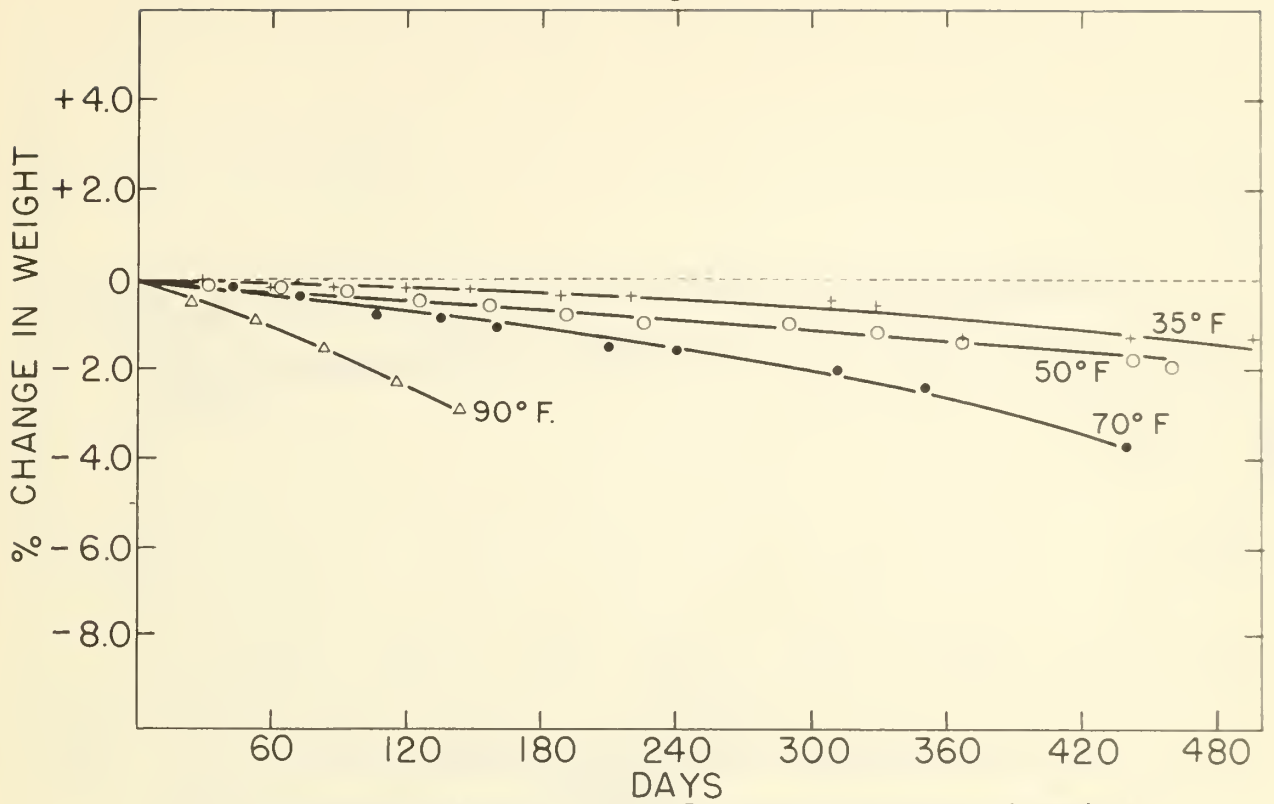


Fig 4: Prunes, Bags, 40% RH. Percent Change in Weight

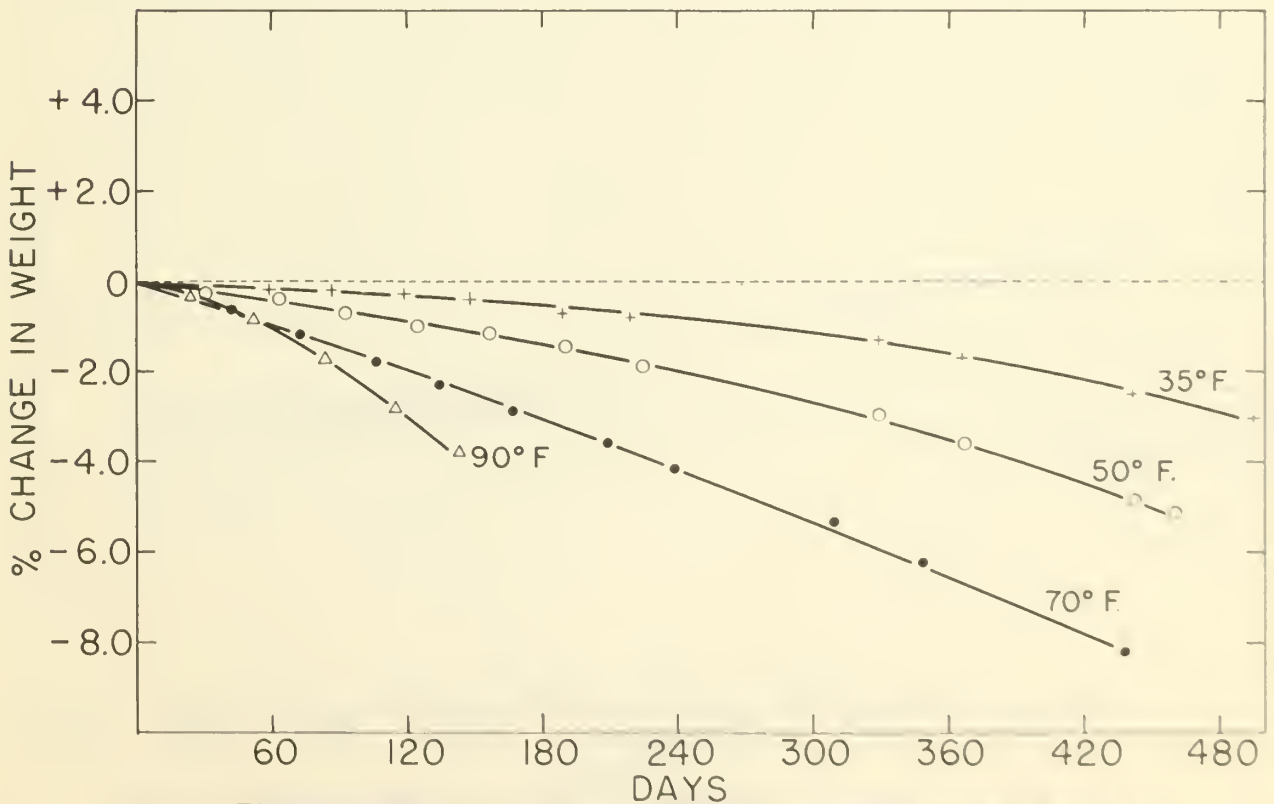


Fig. 5: Prunes, Cartons, 40%RH. Percent Change in Weight

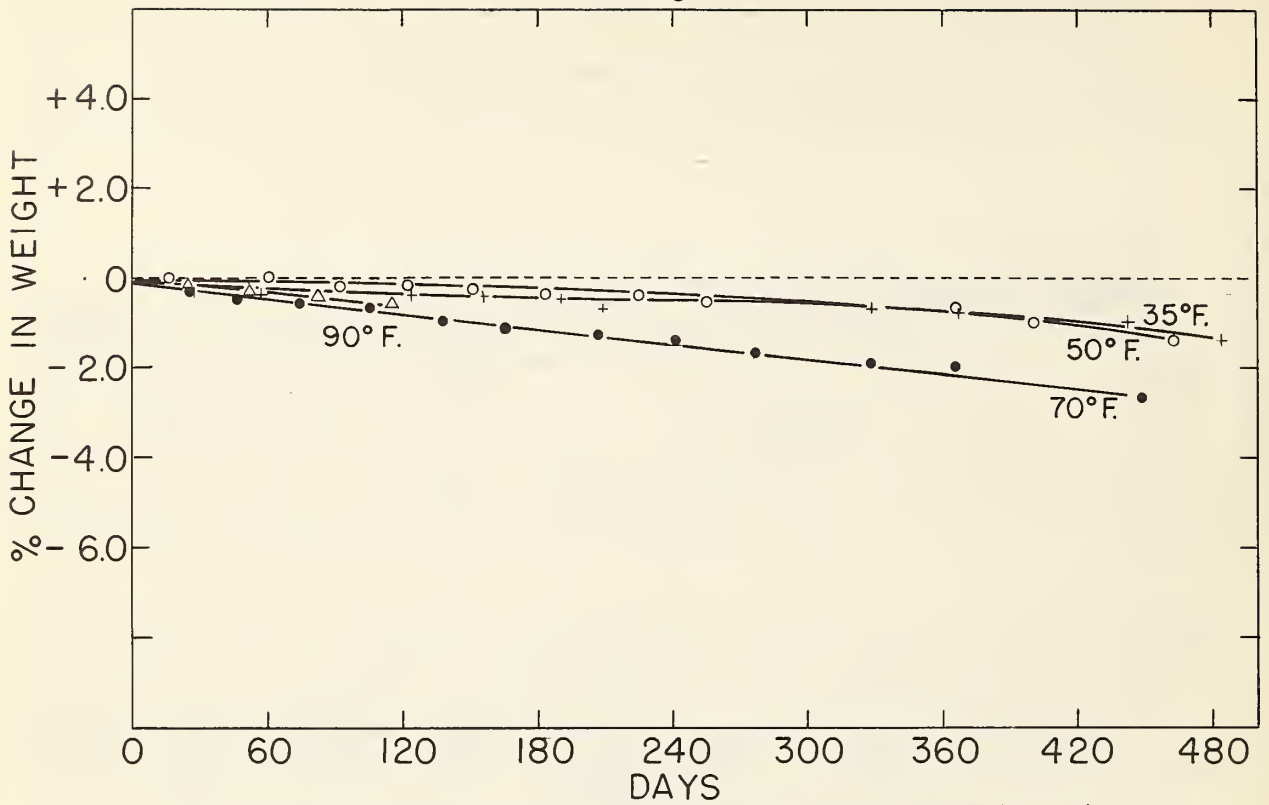


Fig. 6: Prunes, Bags, 60% RH. Percent Change in Weight

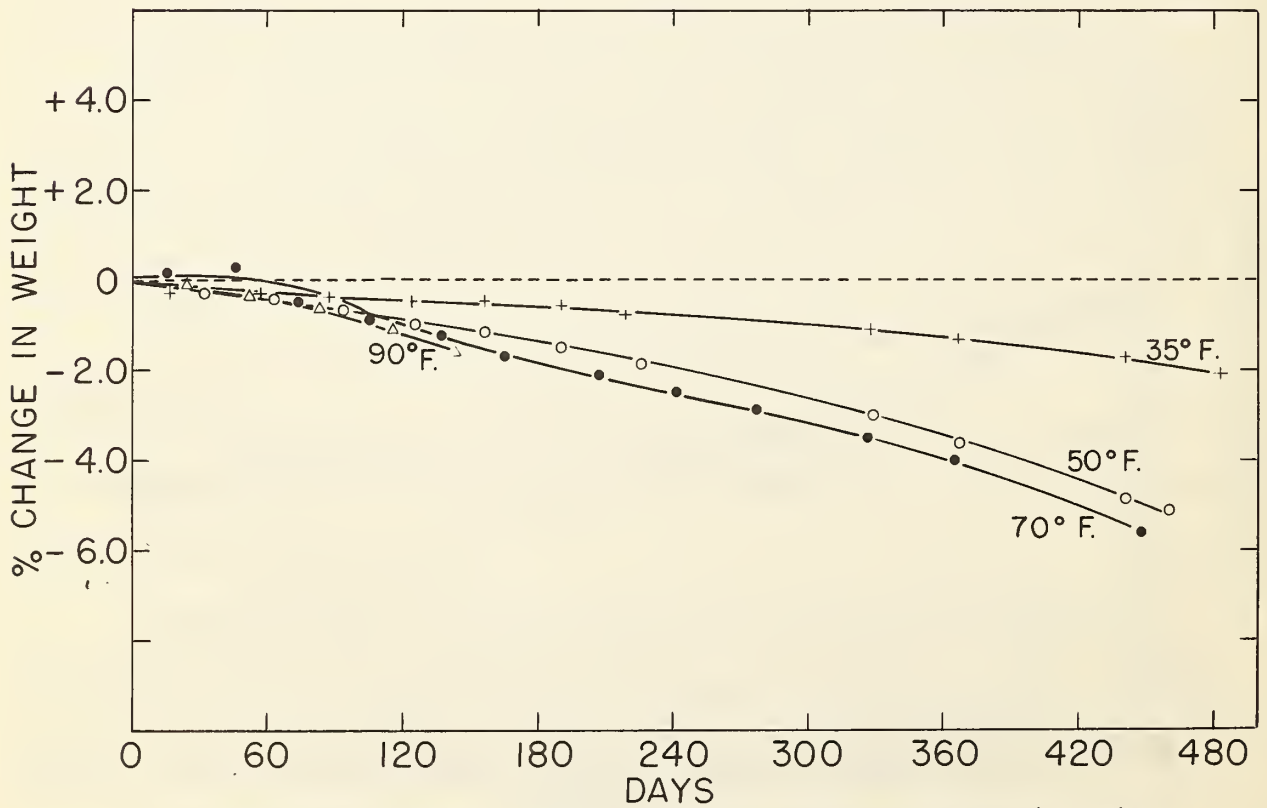


Fig. 7: Prunes, Cartons, 60% RH. Percent Change in Weight

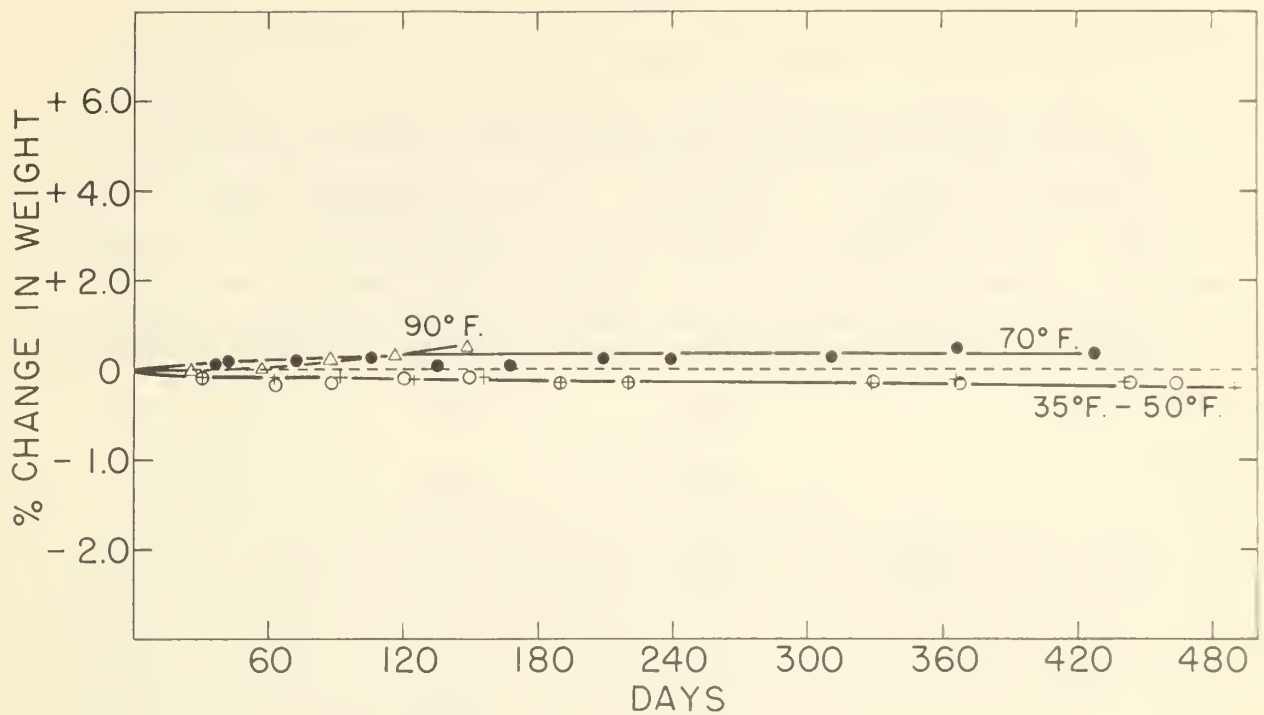


Fig 8: Prunes, Bags, 80% RH. Percent Change in Weight

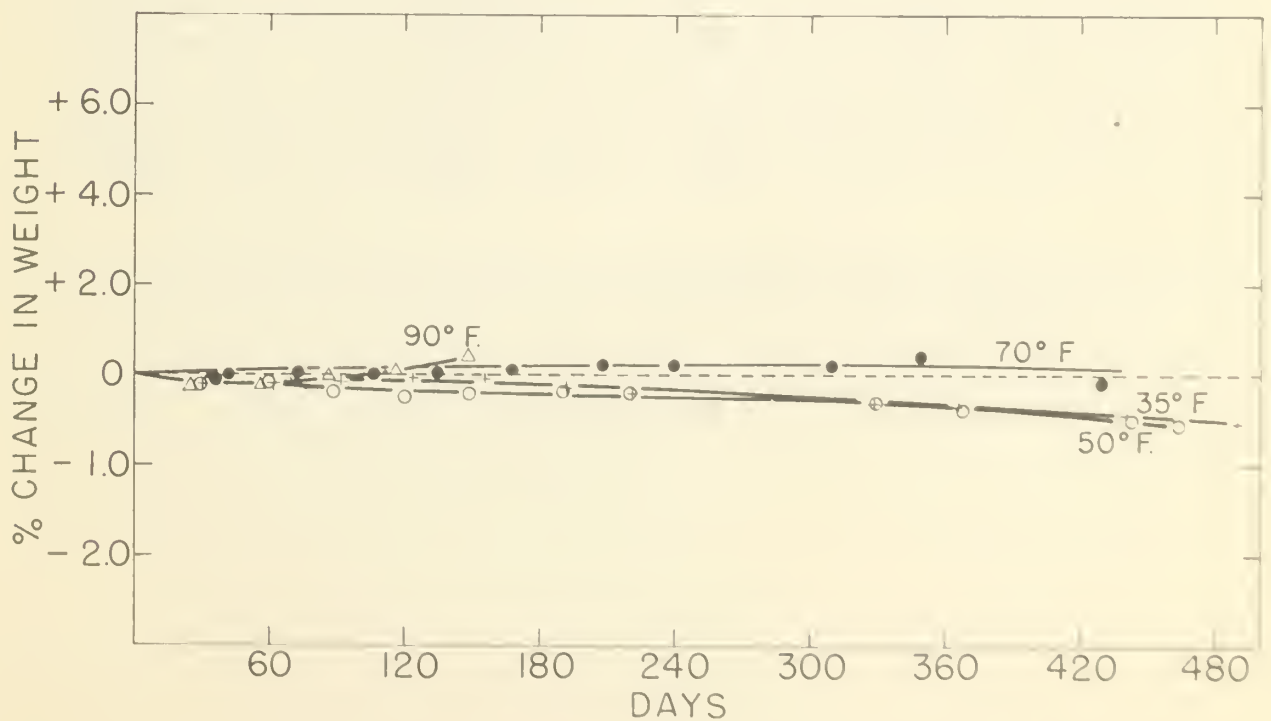


Fig. 9: Prunes, Cartons, 80% RH Percent Change in Weight

Table 2. --Moisture content of stored prunes (vacuum-oven method)

(Initial moisture content: cartons, 26.2 pct.; bags, 26.8 pct.)

Temperature ° F.	Days stored	Percent RH	Percent Moisture (avg. of 4 pkgs.)	
			Cartons	Bags
90	160	40	24.7	24.1
		60	23.4	25.2
		80	26.1	25.9
70	440	40	17.3	22.1
		60	21.1	24.3
		80	25.9	25.1
50	460	40	21.6	23.6
		60	23.8	25.2
		80	25.7	25.3
35	490	40	23.8	24.9
		60	24.7	25.0
		80	25.0	25.3

leakage. At 70° F. the prunes did not show significant changes in visual appearance. At 50° and 35° F. at all three relative humidities many of the bags or prunes showed surface sugaring after about 6 to 8 months, and the amount increased as storage continued. The fruit in cartons did not show a significant change in this respect and maintained a better appearance in cool storage. It should be noted that the prunes contained about 25 percent moisture, which may explain the high rate of sugaring in storage. Higher moisture prunes are known to remain free of sugaring. No evidence of insect growth was noted in any of the packages.

Summary

The results of a time-temperature-humidity study of retail packages of processed dried prunes have been reported. Retail packages of processed dried prunes stored at 35°, 50°, 70° and 90° F. and at 40, 60, and 80 percent relative humidity have been shown to undergo quality changes in some cases. Color changes occur at all temperatures and are independent of the relative humidity of the atmosphere. These changes are measurable even at low temperatures and can be used as a criterion of time-temperature experience as well as an index of quality in retail packages of prunes. Moisture changes take place in both cartons and bags of dried prunes at 40 and 60 percent relative humidity. These changes are more pronounced at 90° and at 70° F. but significant at lower temperatures also. The carton-packed fruit generally lost more weight than the bagged fruits. At 80 percent relative humidity the weight of the packages was practically constant irrespective of package type. Flavor evaluation by triangle taste tests indicated high flavor retention at 70° F. or lower, for at least 12 months. After 12 weeks at 90° F., however, the prunes were distinguishable from the control group by the taste panel.

The quality of prunes was maintained to a higher degree in carton-packed fruit from the standpoint of appearance. The bagged prunes "sugared" extensively at 50° F. and at 35° F. The general overall quality of prunes in cartons remained very good at 35°, 50°, and 70° F. for over 1 year. Prunes at 90° F. after 3 months had developed poor flavor, dark flesh color and general poor quality.

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